

AMENDMENTS TO THE CLAIMS

The claims in this listing will replace all prior versions, and listings, of claims in the application.

Claims 1-19 (Canceled).

20. (New) A reception apparatus comprising:

a generator that generates a sampling timing at a predetermined sampling rate;

a first estimator that estimates a first synchronization timing of a received signal at the sampling timing;

a switch that shifts a phase of the sampling timing;

a second estimator that estimates a second synchronization timing of the received signal at the sampling timing of the shifted phase; and

a third estimator that estimates a third synchronization timing, which is a definitive synchronization timing, from the first synchronization timing and the second synchronization timing,

wherein the switch shifts the phase of the sampling timing at a time interval longer than a symbol duration.

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21. (New) The reception apparatus according to claim 20,
wherein the switch further shifts the phase of the sampling timing into a plurality of
different phases; and

wherein the second estimator further estimates the second synchronization timing at
sampling timings corresponding to the plurality of different phases respectively.

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22. (New) The reception apparatus according to claim 20, wherein the third estimator
further estimates the third synchronization timing at a time resolution twice the time
resolution of said predetermined sampling rate, based on reliability information indicating
a likelihood of the first synchronization timing and the second synchronization timing.

23. (New) The reception apparatus according to claim 20, wherein the third estimator
further chooses the synchronization timing of higher reliability as the third synchronization
timing, based on reliability information indicating a likelihood of the first synchronization
timing and the second synchronization timing.

24. (New) The reception apparatus according to claim 21, wherein the third estimator
further estimates the third synchronization timing through interpolation of the first
synchronization timing and the second synchronization timing, based on reliability

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information indicating a likelihood of the first synchronization timing and the second synchronization timing.

25. (New) The reception apparatus according to claim 20, further comprising a controller that controls a period of an operation mode in which the switch shifts the phase of the sampling timing.

26. (New) The reception apparatus according to claim 25, wherein the switch further fixes the phase of the sampling timing at a phase corresponding, during a mode other than the operation mode, to the third synchronization timing estimated during an earlier operation mode.

27. (New) The reception apparatus according to claim 20, further comprising a transmitter that transmits transmission data using a sampling timing corresponding to the third synchronization timing.

28. (New) A reception apparatus comprising:
a receiver that samples a received signal at a predetermined sampling timing;

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an operator that determines a correlation between the received signal and a known signal sequence through a vector operation;

a first estimator that estimates a first synchronization timing of the received signal based on an operation result of said operator;

an operation value ratio table that stores operation value ratios and a plurality of associated short times, said operation value ratios indicating ratios between a plurality of correlations determined at sampling timings shifted from ideal sampling timings by the short times; and

a second estimator that reads operation value ratio table and detects an operation value ratio closest to a ratio between the correlations corresponding to the first synchronization timing, and estimates a timing shifted from the first synchronization timing by a short time corresponding to the detected operation value ratio as the second synchronization timing.

29. (New) The reception apparatus according to claim 28, further comprising:

a propagation path estimator that estimates a propagation path condition; and

an updater that updates the operation value ratio table based on the propagation path condition.

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30. (New) The reception apparatus according to claim 28, further comprising:

a tap coefficient table that stores tap coefficients and a plurality of associated short times, the tap coefficients corresponding to sampling timings shifted from ideal sampling timings by the short times; and

a canceler that cancels inter symbol interference from the received signal using tap coefficient corresponding to a short time indicating a shift between the first synchronization timing and the second synchronization timing among the tap coefficients in said tap coefficient table.

31. (New) A reception apparatus comprising

a receiver that samples a received signal at a predetermined sampling timing;

a tap coefficient table that stores tap coefficients and a plurality of associated short times, the tap coefficients corresponding to sampling timings shifted from ideal sampling timings by the short times;

a canceler that cancels inter symbol interference from the received signal using the tap coefficients in said tap coefficient table;

an operator that determines correlation between signals having inter symbol interference removed and corresponding to the tap coefficients respectively, and a known signal sequence; and

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an estimator that detects a tap coefficient that yields a maximum operation result in said operator and estimates a timing shifted from the predetermined sampling timing by a short time corresponding to the detected tap coefficient as a synchronization timing of the received signal.

32. (New) The reception apparatus according to claim 31, further comprising a demodulator that demodulates a signal having inter symbol interference removed and corresponding to the tap coefficient detected by the estimator.

33. (New) A reception method comprising:
generating a sampling timing at a predetermined sampling rate;
estimating a first synchronization timing of a received signal at the sampling timing;
shifting a phase of the sampling timing at a time interval longer than a symbol duration;

estimating a second synchronization timing of the received signal at the sampling timing of the shifted phase; and

estimating a third synchronization timing, which is a definitive synchronization timing, from the first synchronization timing and the second synchronization timing.

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34. (New) A reception method comprising:

sampling a received signal at a predetermined sampling timing;

determining a correlation between the received signal and a known signal sequence through vector operation;

estimating a first synchronization timing of the received signal based on a vector operation result;

obtaining, from an operation value ratio table that stores operation value ratios and a plurality of associated short times, the operation value ratios indicating ratios between a plurality of correlations determined at sampling timings shifted from ideal sampling timings by the short times, and detecting an operation value ratio closest to a ratio between the correlations corresponding to the first synchronization timing; and

detecting a timing shifted from the first synchronization timing by a short time corresponding to the detected operation value ratio as a second synchronization timing.

35. (New) A reception method comprising:

sampling a received signal at a predetermined sampling timing;

canceling inter symbol interference from the received signal using tap coefficients in a tap coefficient table which stores tap coefficients and a plurality of associated short times,

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the tap coefficients corresponding to sampling timings shifted from ideal sampling timings by the short times;

A/Cont. *B/Cont.* determining a correlation, through vector operation, between signals having inter symbol interference removed and corresponding to the tap coefficients respectively, and the known signal sequence;

detecting a tap coefficient that gives a maximum vector operation result; and

estimating a timing shifted from the predetermined sampling timing by a short time corresponding to the detected tap coefficient as a synchronization timing of the received signal.
